

Questions to be answered by the end of the EBR Pilot Study:

Pre-EBR Pilot, Site Conditions

- For each area targeted for amendments or injections, immediately prior to (less than 6 months) the first injections or amendments, what were:
 - The total size of the indigenous microbial population in the injection areas?
 - What major classifications of microbes composed this total population, and at what proportion of the total were each classification?
 - The total size of the microbial population capable of conducting sulfate-reduction under current site conditions?
 - The total size of the microbial population capable of biodegrading benzene, under current site conditions?
 - The in-situ rate of benzene biodegradation?
 - How much benzene was being converted into microbial biomass?
 - How much benzene was being fully mineralized to carbon dioxide?
 - What is the dominant terminal-electron acceptor process for the indigenous microbial population?
- Within six months prior to the first injections or amendments:
 - Where were the LNAPL-contaminated plumes of benzene located at this site?
 - Where was dissolved-phase benzene, at concentrations in excess of 5 ug/L, located at the site?
 - How much total LNAPL was present at the start of the EBR pilot?
- Less than three weeks prior to the first injections or amendments, for each groundwater location targeted for injection or amendments, what were:
 - Groundwater temperatures, pH, ORP values, and DO concentrations at the time of testing/monitoring?
 - Groundwater geochemical conditions and parameters key to monitoring biological remediation, including nitrate, ferrous iron, and sulfate concentrations?
 - Benzene concentrations?
 - LNAPL locations and depths?
 - Hydrogen sulfide concentrations?
 - The amount of sulfate calculated to maximize benzene biodegradation?

During EBR Pilot, Site Conditions

- Three weeks following each injection or amendment, for each groundwater location targeted for injections or amendments, what are:
 - Groundwater temperatures, pH, ORP values, and DO concentrations at the time of testing/monitoring?
 - Groundwater geochemical conditions and parameters key to monitoring biological remediation, including nitrate, ferrous iron, and sulfate concentrations?
 - Benzene concentrations?
 - LNAPL locations and depths?

- Hydrogen sulfide concentrations?
- The amount of sulfate calculated to maximize benzene biodegradation?

Post-EBR Injections, Site Conditions

- Between two and four months after the final injections or amendments, for each area targeted for amendments or injections:
 - What is the total size of the indigenous microbial population in the injection areas? How does this compare to the baseline data?
 - What major classifications of microbes compose this total population, and at what proportion of the total were each classification?
 - The total size of the microbial population capable of conducting sulfate-reduction under current site conditions?
 - The total size of the microbial population capable of biodegrading benzene, under current site conditions?
 - The in-situ rate of benzene biodegradation?
 - How much benzene is being converted into microbial biomass?
 - How much benzene is being fully mineralized to carbon dioxide?
 - What is the dominant terminal-electron acceptor process for the indigenous microbial population?
- Between three and six months after the final injections or amendments, for each groundwater location targeted for injection or amendments:
 - Where are the LNAPL-contaminated plumes of benzene located at this site?
 - Where is dissolved-phase benzene, at concentrations in excess of 5 ug/L, located at this site?
 - What are the groundwater temperatures, pH, ORP values, and DO concentrations at the time of testing/monitoring?
 - What are the groundwater geochemical conditions and parameters key to monitoring biological remediation, including nitrate, ferrous iron, and sulfate concentrations?
 - What are the benzene concentrations in the treatment areas and downgradient?
 - Where are LNAPL locations and depths?
 - What are the hydrogen sulfide concentrations?
 - The amount of sulfate calculated to maximize benzene biodegradation?
- What is the calculated reaction rate for sulfate reduction?
- For each sulfate injection, what is the calculated area of influence?
- What is the impact of soil heterogeneity on the movement of sulfate?
- What does the sulfate distribution look like in reality?
- What is the rate of mass transfer from fine-grained soils to zones of sulfate reduction?
- What is the rate of mass transfer from NAPL to zones of sulfate reduction where hydrocarbon substrate is limiting?
- What is the updated time estimate to achieve clean-up goals at this site?
- Do the Pilot Test results justify moving on to full-scale EBR?